

CLAIMS

I claim:

1. A male connector assembly for a matched male and female electrical connector pair, the male connector assembly comprising:

a housing having a longitudinal axis and an opening on one end;

5 a male pin assembly deployed in the housing, the male pin assembly including a plurality of male contact members sized and shaped for selectively making and breaking electrical contact with a corresponding plurality of female contact members on a corresponding female connector assembly;

10 the male pin assembly coupled to a floating carrier, the floating carrier configured to displace along the longitudinal axis between a first floating carrier position and a second floating carrier position, the first floating carrier position located nearer to opening than the second floating carrier position;

15 a substantially annular wiper piston deployed about the male pin assembly and interposed between the floating carrier and the opening, the wiper piston configured to displace along the longitudinal axis between a first wiper piston position and a second wiper piston position, the first wiper piston position located nearer to the opening than the second wiper piston position; and

the wiper piston disposed to sealingly isolate at least one of the plurality of male contact members from the opening when the wiper piston is in the first wiper piston position.

20 2. The male connector assembly of claim 1, further comprising a first substantially cylindrical drill collar having a threaded end portion, the male connector

assembly deployed substantially coaxially within the first drill collar so that the opening in the housing is proximate to the threaded end portion of the first drill collar.

3. The male connector assembly of claim 2, further comprising a second substantially cylindrical drill collar also having a threaded end portion, wherein the first drill collar is configured to threadably couple with the second drill collar via their corresponding threaded end portions, the female connector assembly deployed substantially coaxially within the second drill collar such that coupling the first and second drill collars via their threaded end portions enables electrical communication between the plurality of male contact members and the corresponding plurality of female contact members.

4. The male connector assembly of claim 1, wherein one of the plurality of contact members on the male pin assembly is located centrally on one end of the male pin assembly and proximate to the opening in the housing.

5. The male connector assembly of claim 4, wherein:
the plurality of contact members further comprises at least two annularly shaped contact members that are longitudinally spaced along the male pin assembly;

said central contact member being electrically coupled to a conductive rod deployed in a core portion of the male pin assembly, the conductive rod being further deployed in a substantially insulating sleeve; and

said at least two annularly shaped contact members being deployed substantially coaxially about the insulating sleeve, each annularly shaped contact member separated

from neighboring annularly shaped contact members by a spacer including an annular
insulating spacer.

6. The male connector assembly of claim 1, wherein at least two of the plurality of contact members are annularly shaped and longitudinally spaced along the male pin assembly, each annular contact member separated from its neighboring annular contact members by a spacer including an annular insulating spacer.

7. The male connector assembly of claim 1, further comprising a spring member deployed between the wiper piston and the floating carrier, the spring member biasing the wiper piston towards the first wiper piston position.

8. The male connector assembly of claim 7, wherein the spring member is substantially uncompressed when the wiper piston is in the first wiper piston position and substantially fully compressed when the wiper piston is in the second wiper piston position.

9. The male connector assembly of claim 1, further comprising a sealing member deployed on an inner annular surface of the wiper piston, the sealing member disposed to wipe an outer surface of at least one of the plurality of contact members deployed on the male pin assembly when the wiper piston displaces between first and second wiper piston positions.

10. The male connector assembly of claim 1, wherein:

the wiper piston is located substantially in the first wiper piston position when the male connector assembly is disconnected from the corresponding female connector assembly; and

5 the wiper piston is displaced substantially to the second wiper piston position when the male connector assembly is fully connected with the corresponding female connector assembly.

11. The male connector assembly of claim 1, further comprising a spring member deployed between the floating carrier and a buttress member rigidly affixed within the housing, the buttress member located further distal from the opening than the floating carrier.

12. The male connector assembly of claim 11, wherein:

the spring member is partially compressed when the floating carrier is in the first floating carrier position; and

5 the spring member is substantially fully compressed when the floating carrier is in the second floating carrier position.

13. The male connector assembly of claim 1, wherein:

the floating carrier is biased in the first floating carrier position when the male connector assembly is disconnected from the corresponding female connector assembly; and

5 the floating carrier is displaced from the first floating carrier position towards the second floating carrier position when the male connector assembly is fully connected with

the corresponding female connector assembly.

14. The male connector assembly of claim 13, wherein each of the plurality of male contact members remain in electrical communication with the corresponding ones of the plurality of female contact members while the floating carrier reciprocates between first and second floating carrier positions.

15. A female connector assembly for a matched male and female electrical connector pair, the female connector assembly comprising:

a housing having a longitudinal axis and an opening on one end thereof, the housing providing an internal chamber between first and second bulkheads, the internal chamber disposed to be filled with a fluid;

a female socket assembly having a plurality of female contact members, the female socket assembly deployed in the internal chamber of the housing, the plurality of female contact members sized and shaped for selectively making and breaking electrical contact with a corresponding plurality of male contact members on a corresponding male connector assembly;

an internal housing deployed in the internal chamber of the female housing, the internal housing providing a fluid-balancing chamber between a fluid balancing piston and the first bulkhead;

the fluid-balancing piston configured to displace along the longitudinal axis between first and second fluid-balancing piston positions in the fluid-balancing chamber; and

the fluid-balancing chamber having a first volume when the fluid-balancing piston is in its first position and a second volume when the fluid-balancing piston is in its second position, the difference between the first and second volumes being substantially equal to a volume of the fluid displaced in the internal chamber by a male pin on the corresponding male connector assembly when male and female connector assemblies are connected.

16. The female connector assembly of claim 15, further comprising a first

substantially cylindrical drill collar having a threaded end portion, the female connector assembly deployed substantially coaxially within the first drill collar so that the opening in the housing is proximate to the threaded end portion of the drill collar.

17. The female connector assembly of claim 16, further comprising a second substantially cylindrical drill collar also having a threaded end portion, wherein the first drill collar is configured to threadably couple with the second drill collar via their corresponding threaded end portions, the male connector assembly deployed substantially coaxially within the second drill collar such that coupling the first and second drill collars via their threaded end portions enables electrical communication between the plurality of female contact members and the corresponding plurality of male contact members.

18. The female connector assembly of claim 15, wherein:

the socket assembly includes a bore; and

the female connector assembly further comprises a shaft assembly receivable in the bore of the socket assembly, the shaft assembly configured to displace along the longitudinal axis with the fluid-balancing piston between the first and second positions, at least a portion of the shaft assembly deployed between the fluid-balancing piston and the opening, the shaft assembly disposed to sealingly isolate at least one of the plurality of female contact members from the opening when the shaft assembly is in the first position.

19. The female connector assembly of claim 18, further comprising a sealing member deployed on an outer surface of the shaft assembly, the sealing member disposed to wipe an inner surface of at least one of the plurality of female contact members

5 deployed on the female socket assembly when the shaft assembly displaces between first and second positions.

20. The female connector assembly of claim 18, wherein the end of the shaft assembly located proximate to the opening includes a recessed electrical contact, the recessed electrical contact being suitable for receiving and electrically coupling with a corresponding protruding electrical contact on the male connector assembly.

21. The female connector assembly of claim 20, wherein:
the shaft assembly comprises an electrically conductive material; and
the fluid-balancing chamber includes a spring member deployed therein, the spring member disposed to bias the fluid-balancing piston and the shaft assembly towards
5 the first position, the spring member also comprising an electrically conductive material and electrically coupled through the shaft assembly to the recessed electrical contact.

22. The female connector assembly of claim 15, wherein at least two of the plurality of female contact members are ring shaped and longitudinally spaced, each ring shaped female contact member separated from its neighboring ring shaped contact members by a spacer including a ring shaped insulator.

23. The female connector assembly of claim 22, wherein each of said at least two ring female contact members further includes a ring shaped, flexible, and electrically conductive insert deployed in an electrically conductive contact holder, each insert including a plurality of elongated tabs, each tab having first and second portions, the first

5 portion being resilient and extending radially inwards towards a center of the ring shaped
insert so as to be disposed to engage and make electrical contact with a corresponding
annular contact member of the corresponding male connector assembly, the second
portion extending radially outwards away from the center of the ring shaped insert so as
to be disposed to engage and make electrical contact with the corresponding contact
10 holder.

24. The female connector assembly of claim 15, further comprising a spring
member deployed in the fluid-balancing chamber, the spring member disposed to bias the
fluid-balancing piston towards the first position.

25. The female connector assembly of claim 24, wherein:
the spring member is substantially uncompressed when the shaft assembly and
fluid-balancing piston are in the first position; and
the spring member is compressed when the shaft assembly and the fluid-balancing
5 piston are in the second position.

26. The female connector assembly of claim 15, wherein the internal chamber
is disposed to be filled with a substantially non-conductive oil.

27. The female connector assembly of claim 15, wherein the fluid-balancing
chamber is disposed to be filled with a compressible fluid.

28. The female connector assembly of claim 15, wherein fluid in the internal

chamber is disposed to be held at pressure, and wherein said pressure remains substantially constant during connecting and disconnecting of the female connector assembly with the corresponding male connector assembly.

29. An electrical connector for selectively connecting and disconnecting a plurality of electrical lines, the electrical connector comprising:

a male housing having a longitudinal axis and two ends, the male housing including a first opening on one end thereof;

5 a male pin assembly deployed in the male housing, the male pin assembly including a plurality of male contact members;

a substantially annular wiper piston deployed about the male pin assembly in the male housing, the wiper piston configured to displace along the longitudinal axis of the male housing between a first wiper piston position and a second wiper piston position, the
10 first wiper piston position located nearer to the first opening than the second wiper piston position, the wiper piston disposed to sealingly isolate at least one of the plurality of male contact members from the first opening when the wiper piston is in the first wiper piston position;

a female housing having a longitudinal axis and two ends, the female housing
15 including a second opening on one end thereof;

a female socket assembly deployed in the female housing, the female socket assembly including a plurality of female contact members and having a bore configured for receiving a portion of the male pin assembly;

a shaft assembly receivable in the bore of the female socket assembly, the shaft
20 assembly configured to displace along the longitudinal axis of the female housing between a first shaft assembly position and a second shaft assembly position, the first shaft assembly position located nearer to the second opening than the second shaft assembly position, the shaft assembly disposed to sealingly isolate at least one of the plurality of female contact members from the second opening when the shaft assembly is

25 in the first shaft assembly position;

the male pin assembly configured to engage and disengage with the female socket assembly such that each of the plurality male contact members electrically couple and decouple with corresponding ones of the plurality of female contact members upon connecting and disconnecting of the electrical connector.

30. The electrical connector of claim 29, further comprising first and second substantially cylindrical drill collars each having a threaded end portion, and wherein:

the male housing is deployed in the first drill collar with the first opening proximate to the threaded end portion of the first drill collar;

5 the female housing is deployed in the second drill collar with the second opening proximate to the threaded end portion of the second drill collar; and

connection of the first and second drill collars via respective threaded end portions enables electrical communication between the plurality of male contact members and the plurality of female contact members.

31. The electrical connector of claim 29, further comprising:

a first sealing member deployed on an inner surface of the wiper piston, the first sealing member disposed to wipe an outer surface of at least one of the plurality of male contact members deployed on the male pin assembly when the wiper piston displaces
5 between first and second wiper piston positions; and

a second sealing member deployed on an outer surface of the shaft assembly, the second sealing member disposed to wipe an inner surface of at least one of the plurality of female contact members deployed on the female socket assembly when the shaft

assembly displaces between first and second shaft assembly positions.

32. The electrical connector of claim 29, wherein:

the wiper piston is located substantially in the first wiper piston position and the shaft assembly is located substantially in the first shaft assembly position when the electrical connector is disconnected; and

5 the wiper piston is displaced substantially to the second wiper piston position and the shaft assembly is displaced substantially to the second shaft assembly position when the electrical connector is connected.

33. The electrical connector of claim 29, further comprising:

a protruding contact located centrally on an end of the male pin assembly proximate to the first opening;

5 a recessed electrical contact located on an end of the shaft assembly proximate to the second opening; and

the recessed electrical contact and the protruding contact configured for electrically coupling with one another when the electrical connector is connected.

34. The electrical connector of claim 29, wherein:

the plurality of male contact members further includes at least two annularly shaped contact members that are longitudinally spaced along the male pin assembly;

5 the plurality of female contact members further includes at least two ring shaped contact members that are longitudinally spaced in the female socket assembly; and

said at least two annularly shaped contact members and said at least two ring

shaped contact members are configured for electrical coupling one with another when the electrical connector is connected.

35. The electrical connector of claim 29, wherein:

the male pin assembly is coupled to a floating carrier, the floating carrier configured to displace along the longitudinal axis of the male housing between a first floating carrier position and a second floating carrier position;

5 the floating carrier is located substantially in the first position when the electrical connector is disconnected and displaced between the first position and the second position when the electrical connector is connected; and

each of the plurality of male contact members remain in electrical communication with corresponding ones of the plurality of female contact members while the floating
10 carrier reciprocates between the first and second floating carrier positions.

36. An electrical connector for selectively connecting and disconnecting a plurality of electrical lines, the electrical connector comprising:

a male housing having a longitudinal axis and two ends with a first opening on one end thereof;

5 a male pin assembly deployed in the male housing, the male pin assembly including a plurality of male contact members;

a female housing having a longitudinal axis and two ends with a second opening on one end thereof, the female housing providing an internal chamber between first and second bulkheads, the internal chamber disposed to be filled with a fluid;

10 a female socket assembly having a plurality of female contact members, the female socket assembly deployed in the internal chamber;

an internal housing deployed in the internal chamber of the female housing, the internal housing providing a fluid-balancing chamber between a fluid balancing piston and the first bulkhead;

15 the male pin assembly configured to engage and disengage with the female socket assembly such that each of the plurality male contact members electrically couple and decouple with corresponding ones of the plurality of female contact members upon connecting and disconnecting of the electrical connector;

20 the fluid-balancing piston configured to displace along the longitudinal axis of the female housing between first and second positions in the fluid-balancing chamber; and

the fluid-balancing chamber having a first volume when the fluid-balancing piston is in the first position and a second volume when the fluid-balancing piston is in the second position, the difference between the first and second volumes being substantially equal to a volume of the fluid displaced in the internal chamber by the male pin assembly

25 when the electrical connector is connected.

37. The electrical connector of claim 36, further comprising first and second substantially cylindrical drill collars each having a threaded end portion, and wherein:

 the male housing is deployed in the first drill collar with the first opening proximate to the threaded end portion of the first drill collar;

5 the female housing is deployed in the second drill collar with the second opening proximate to the threaded end portion of the second drill collar; and

 connection of the first and second drill collars via respective threaded end portions enables electrical communication between the plurality of male contact members and the plurality of female contact members.

38. The electrical connector of claim 36, further comprising a spring member deployed in the fluid-balancing chamber, the spring member disposed to bias the fluid-balancing piston towards the first position, wherein the spring member is substantially uncompressed when the shaft assembly and fluid-balancing piston are in the first position
5 and the spring member is compressed when the shaft assembly and the fluid-balancing piston are in the second position.

39. The electrical connector of claim 36, wherein:

 the internal chamber is disposed to be filled with a substantially non-conductive oil; and

 the fluid-balancing chamber is disposed to be filled with a compressible fluid.

40. The electrical connector of claim 36, wherein:

the fluid in the internal chamber is disposed to be held at pressure; and

said pressure remains substantially constant during connecting and disconnecting of the electrical connector.

41. The electrical connector of claim 36, wherein:

the plurality of male contact members further includes at least two annularly shaped contact members that are longitudinally spaced along the male pin assembly;

the plurality of female contact members further includes at least two ring shaped contact members that are longitudinally spaced in the female socket assembly; and

said at least two annularly shaped contact members and said at least two ring shaped contact members are configured for electrical coupling one with another when the electrical connector is connected.

42. The electrical connector of claim 36, wherein

the male pin assembly is coupled to a floating carrier, the floating carrier configured to displace along the longitudinal axis of the male housing between a first floating carrier position and a second floating carrier position;

the floating carrier is located substantially in the first position when the electrical connector is disconnected and displaced between the first position and the second position when the electrical connector is connected; and

each of the plurality of male contact members remain in electrical communication with corresponding ones of the plurality of female contact members while the floating carrier reciprocates between the first and second floating carrier positions.

43. The electrical connector of claim 36, further comprising:

a substantially annular wiper piston deployed about the male pin assembly in the male housing, the wiper piston configured to displace along the longitudinal axis of the male housing between a first wiper piston position and a second wiper piston position, the first wiper piston position located nearer to the first opening than the second wiper piston position, the wiper piston disposed to sealingly isolate at least one of the plurality of male contact members from the first opening when the wiper piston is in the first wiper piston position; and

a shaft assembly receivable in a bore in the female socket assembly, the shaft assembly configured to displace along the longitudinal axis of the female housing between a first shaft assembly position and a second shaft assembly position, the first shaft assembly position located nearer to the second opening than the second shaft assembly position, the shaft assembly disposed to sealingly isolate at least one of the plurality of female contact members from the second opening when the shaft assembly is in the first shaft assembly position.

44. The electrical connector of claim 43, wherein the male pin assembly and the shaft assembly each have two ends, the electrical connector further comprising:

a protruding contact located centrally on an end of the male pin assembly deployed proximate to the first opening; and

a recessed electrical contact located on an end of the shaft assembly deployed proximate to the second opening, the recessed electrical contact and the protruding contact configured for electrical coupling one with another when the electrical connector

is connected.

45. The electrical connector of claim 43, wherein:

the male pin assembly is coupled to a floating carrier, the floating carrier configured to displace along the longitudinal axis of the male housing between a first floating carrier position and a second floating carrier position;

5 the floating carrier is located substantially in the first position when the electrical connector is disconnected, the floating carrier displaced between the first and second floating carrier positions when the electrical connector is connected; and

each of the plurality of male contact members remain in electrical communication with corresponding ones of the plurality of female contact members while the floating
10 carrier reciprocates between the first and second floating carrier positions.

46. An electrical connector for selectively connecting and disconnecting a plurality of electrical lines, the electrical connector comprising:

a male housing having a longitudinal axis and two ends with a first opening on one end thereof;

5 a male pin assembly deployed in the male housing, the male pin assembly including a plurality of male contact members;

the male pin assembly coupled to a floating carrier, the floating carrier configured to displace along the longitudinal axis of the male housing between a first floating carrier position and a second floating carrier position;

10 a female housing having a longitudinal axis and two ends with a second opening one end thereof;

a female socket assembly deployed in the female housing, the female socket assembly including a plurality of female contact members;

15 the male pin assembly configured to engage and disengage with the female socket assembly such that each of the plurality of male contact members electrically couple and decouple with corresponding ones of the plurality of female contact members upon connecting and disconnecting of the electrical connector;

20 wherein the floating carrier is located substantially in the first position when the electrical connector is disconnected, the floating carrier displaced between first and second floating carrier positions when the electrical connector is connected; and

wherein each of the plurality of male contact members remain in electrical communication with the corresponding ones of the plurality of female contact members while the floating carrier reciprocates between the first and second floating carrier positions.

47. The electrical connector of claim 46, further comprising first and second substantially cylindrical drill collars each having a threaded end portion, and wherein:

the male housing is deployed in the first drill collar with the first opening proximate to the threaded end portion of the first drill collar;

5 the female housing is deployed in the second drill collar with the second opening proximate to the threaded end portion of the second drill collar; and

connection of the first and second drill collars via respective threaded end portions enables electrical communication between the plurality of male contact members and the plurality of female contact members.

48. The electrical connector of claim 46, further comprising a spring member deployed between the floating carrier and a buttress member rigidly affixed within the housing, the buttress member located further distal from the first opening than the floating carrier, wherein the spring member is partially compressed when the floating carrier is in the first floating carrier position and the spring member is substantially fully compressed
5 when the floating carrier is in the second floating carrier position.

49. The electrical connector of claim 46, wherein:

the floating carrier is biased in the first floating carrier position when the electrical connector is disconnected; and

5 the floating carrier is displaced between the first floating carrier position and the second floating carrier position when the electrical connector is fully connected.

50. The electrical connector of claim 46, wherein:

the plurality of male contact members further includes at least two annularly shaped contact members that are longitudinally spaced along the male pin assembly;

the plurality of female contact members further includes at least two ring shaped
5 contact members that are longitudinally spaced in the female socket assembly; and

said at least two annularly shaped contact members and said at least two ring shaped contact members are configured for electrical coupling one with another when the electrical connector is connected.

51. A downhole tool including first and second modules deployed in corresponding first and second drill collars, the first and second drill collars each having at least a first threaded end, the downhole tool including an electrical connector for selectively electrically coupling and decoupling the first and second modules, the electrical connector comprising:

a two-ended male housing deployed in the first module, the male housing having a first opening on one end thereof located proximate to the first threaded end of the first drill collar;

a male pin assembly deployed in the male housing, the male pin assembly including a plurality of male contact members;

a two-ended female housing deployed in the second module, the female housing having a longitudinal axis and a second opening on one end thereof located proximate to the first threaded end of the second drill collar, the female housing providing an internal chamber between first and second bulkheads, the internal chamber disposed to be filled with a fluid;

a female socket assembly having a plurality of female contact members, the female socket assembly deployed in the internal chamber;

an internal housing deployed in the internal chamber of the female housing, the internal housing providing a fluid-balancing chamber between a fluid balancing piston and the first bulkhead;

the male pin assembly configured to engage and disengage with the female socket assembly such that each of the plurality male contact members electrically couple and decouple with corresponding ones of the plurality of female contact members upon connecting and disconnecting of the electrical connector;

25 the fluid-balancing piston configured to displace along the longitudinal axis of the female housing between first and second fluid-balancing piston positions in the fluid-balancing chamber; and

 the fluid-balancing chamber having a first volume when the fluid-balancing piston is in its first position and a second volume when the fluid-balancing piston is in its second
30 position, the difference between the first and second volumes being substantially equal to a volume of the fluid displaced in the internal chamber by the male pin assembly when the electrical connector is connected.

52. A modular measurement while drilling tool comprising:

a plurality of measurement while drilling modules;

each of the plurality of measurement while drilling modules deployed within a corresponding drill collar, the drill collars each having first and second opposing threaded end portions for selectively coupling and decoupling one with another;

first selected ones of the measurement while drilling modules including a male electrical connector assembly, each male electrical connector assembly deployed proximate to the first threaded end of its corresponding drill collar, second selected ones of the measurement while drilling modules including a female electrical connector assembly, each female electrical connector assembly deployed proximate to the second threaded end of its corresponding drill collar;

each male electrical connector assembly including:

a two-ended male housing having a first opening on one end thereof located proximate to the first threaded end; and

a male pin assembly deployed in the male housing, the male pin assembly including a plurality of male contact members; and

each female electrical connector assembly including:

a two-ended female housing having a longitudinal axis and a second opening on one end thereof located proximate to the second threaded end, the female housing providing an internal chamber between first and second bulkheads, the internal chamber disposed to be filled with a fluid;

a female socket assembly having a plurality of female contact members, the female socket assembly deployed in the internal chamber;

an internal housing deployed in the internal chamber of the female housing, the

25 internal housing providing a fluid-balancing chamber between a fluid balancing piston and the first bulkhead;

the fluid-balancing piston configured to displace along the longitudinal axis of the female housing between first and second fluid-balancing piston positions in the fluid-balancing chamber;

30 the fluid-balancing chamber having a first volume when the fluid-balancing piston is in its first position and a second volume when the fluid-balancing piston is in its second position, the difference between the first and second volumes being substantially equal to a volume of the fluid displaced in the internal chamber by the male pin assembly when the electrical connector is connected;

35 wherein each male pin assembly is configured to engage and disengage with an opposing female socket assembly such that each of the plurality male contact members electrically couple and decouple with corresponding ones of the plurality of female contact members when the first and second opposing threaded end portions of surrounding drill collars are threaded together.

53. The modular measurement while drilling tool of claim 52, wherein at least one of the plurality of measurement while drilling modules is selected from the group consisting of sensor modules, communications modules, formation fluid sampling modules, and power modules.